The documentation and process conversion measures necessary to comply with this revision shall be completed by 19 November 1994

INCH-POUND

MIL-S-19500/540A
19 August 1994
MIL-S-19500/540(USAF)
30 April 1980

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP SILICON, POWER
TYPE 2N6298, 2N6299 JAN, JANTX, AND JANTXV

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for PNP, Darlington, silicon, power transistors. Three levels of product assurance is provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See 3.3 (similar to TO-66).

1.3 Maximum ratings.

Type	P_T 1/		V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_B	T_{OP} and T_{STG}
	T_C = 0°C	T_C = 100°C						
	W	W	V dc	V dc	V dc	A dc	mA dc	°C
2N6298	75	32	60	60	5	8	120	-65 TO +175
2N6299	75	32	80	80	5	8	120	-65 TO +175

1/ Derate linearly at 0.428 W/°C above T_C > 0°C.

1.4 Primary electrical characteristics.

	h_{FE2} 1/	h_{FE3} 1/	$\|h_{fe}\|$	C_{obo}	Pulse response	
	V_{CE} = 3 V dc, I_C = 4 A dc	V_{CE} = 3 V dc, I_C = 8 A dc	V_{CE} = 3 V dc, I_C = 3 A dc, f = 1 MHz	100 kHz ≤ f ≤ 1 MHz, V_{CB} = 10 V dc, I_E = 0	t_{on}	t_{off}
				pF	µs	µs
Min	750	100	25			
Max	18000		350	200	2.0	8.0

	$V_{BE(sat)}$ I_C = 8 A dc, I_B = 80 mA dc 1/	$V_{CE(sat)2}$ I_C = 8 A dc, I_B = 80 mA dc 1/	h_{fe} V_{CE} = 3 V dc, I_C = 3 A dc, f = 1 kHz	$R_{\theta JC}$
	V dc	V dc		°C/W
Min			300	
Max	4.0	3.0		2.33

1/ Pulsed (see 4.5.1).

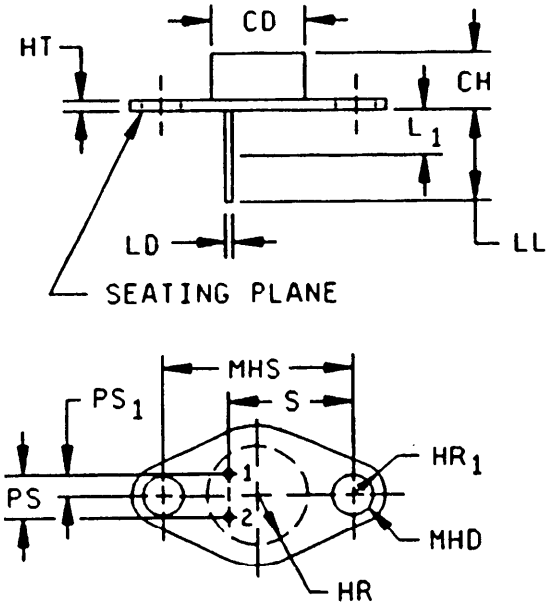
Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Electronics Supply Center, ATTN: DESC-ELDT, 1507 Wilmington Pike, Dayton, OH 45444-5765, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5961

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Symbol	Inches		Millimeters		
	Min	Max	Min	Max	
CD		.620		15.76	
CH	.250	.340	6.35	8.64	
HR		.350		8.89	4
HT	.050	.075	1.27	1.91	
HR_1	.115	.145	2.92	3.68	4
LD	.028	.034	.71	.86	4,6
LL	.360	.500	9.14	12.70	
L_1		.050		1.27	6
MHD	.142	.152	3.61	3.86	4
MHS	.958	.962	24.33	24.43	
PS	.190	.210	4.83	5.33	3
PS1	.093	.107	2.36	2.72	3
S	.570	.590	14.48	14.99	
Notes	1, 2, 5, 7				



NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. These dimensions should be measured at points .050 inch (1.27 mm) +.005 inch (0.13 mm) -.000 inch (0.00 mm) below seating plane. When gauge is not used, measurement will be made at the seating plane.
4. Two places.
5. The seating plane of the header shall be flat within .001 inch (0.03 mm) concave to .004 inch (0.10 mm) convex inside a .930 inch (23.62 mm) diameter circle on the center of the header and flat within .001 inch (0.03 mm) concave to .006 inch (0.15 mm) convex overall.
6. Lead diameter shall not exceed twice LD within L_1.
7. Lead number 1 is the emitter, lead 2 is the base, case is the collector
8. In accordance with ANSI Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions (Similar to TO-66).

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Defense Printing Service Detachment Office, Building 40 (Customer Service), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitaion (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Y14.5M - Dimensioning and Tolerancing. (Dod adopted)

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018-3308.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500 and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in figure 1, (similar to TO-66).

3.3.1 Lead finish. Lead finish shall be solderable as defined in MIL-S-19500.

3.4 Marking. Marking shall be in accordance with MIL-S-19500.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500.

4.3 Screening (JANTX and JANTXV only). Screening shall be in accordance with table II of MIL-S-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table II of MIL-S-19500)	Measurements JANTX and JANTXV levels only
11	I_{CEX1} and h_{FE2}
12	See 4.3.1
13	Subgroup 2 of table I herein; I_{CEX1} = 100 percent of initial value or 100 μA dc whichever is greater. Δh_{FE2} = ±40 percent.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: V_{CE} ≥ 10 V dc; T_J = 162.5°C ± 12.5°C.

NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500 and table I herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IVb (JAN, JANTX, and JANTXV) of MIL-S-19500. Electrical measurements (end-points) shall be in accordance with the table I, group A, subgroup 2 herein.

Subgroup	Method	Condition
B3	1037	V_{CE} ≥ 10 V dc; Δ_{TJ} between cycles ≥ 100°C; t_{on} = t_{off} = 3 minutes for 2,000 cycles. No heat sink or forced-air cooling on the devices shall be permitted.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500. Electrical measurements (end-points) shall be in accordance with the table I, group A, subgroup 2 herein.

Subgroup	Method	Condition
C2	2036	Test condition A; weight = 10 lbs., time = 15 seconds.
C6	1037	V_{CE} ≥ 10 V dc; Δ_{TJ} between cycles ≥ 100°C; t_{on} = t_{off} = 3 minutes for 6,000 cycles. No heat sink or forced-air cooling on device shall be permitted.

4.5 Method of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Breakdown voltage, collector to emitter	3011	Bias condition D; I_C = 100 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$			
2N6298				60		V dc
2N6299				80		V dc
Collector to emitter cutoff current	3041	Bias condition A; V_{BE} = 1.5 V dc	I_{CEX1}			
2N6298		V_{CE} = 60 V dc			0.5	mA dc
2N6299		V_{CE} = 80 V dc			0.5	mA dc
Collector to emitter cutoff current	3041	Bias condition D	I_{CEO}			
2N6298		V_{CE} = 30 V dc			0.5	mA dc
2N6299		V_{CE} = 40 V dc			0.5	mA dc
Emitter to base cutoff current	3061	Bias condition D; V_{EB} = 5 V dc	I_{EBO}		2.0	mA dc
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 1 A dc; pulsed (see 4.5.1)	h_{FE1}	500		
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 4 A dc; pulsed (see 4.5.1)	h_{FE2}	750	18000	
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 8 A dc; pulsed (see 4.5.1)	h_{FE3}	100		
Base emitter voltage (nonsaturated)	3066	Test condition B; V_{CE} = 3 V dc; I_C = 4 A dc; pulsed (see 4.5.1)	$V_{BE(on)}$		2.8	V dc
Base emitter voltage (saturated)	3066	Test condition A; I_C = 8 A dc; I_B = 80 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)}$		4.0	V dc
Collector to emitter voltage (saturated)	3071	I_C = 4 A dc; I_B = 16 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		2.0	V dc

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Collector to emitter voltage (saturated)	3071	I_C = 8 A dc; I_B = 80 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		3.0	V dc
Subgroup 3						
High temperature operation:		T_A = +150°C				
Collector to emitter cutoff current	3041	Bias condition A; V_{BE} = 1.5 V dc	I_{CEX2}			
2N6298		V_{CE} = 60 V dc			5.0	mA dc
2N6299		V_{CE} = 80 V dc			5.0	mA dc
Low temperature operation:		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 4 A dc; pulsed (see 4.5.1)	h_{FE4}	200		
Subgroup 4						
Small-signal short-circuit forward current transfer ratio	3206	V_{CE} = 3 V dc; I_C = 3 A dc; f = 1 kHz	h_{fe}	300		
Magnitude of small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 3 V dc; I_C = 3 A dc; f = 1.0 MHz	$\lvert h_{fe} \rvert$	25	350	
Pulse response						
Turn-on time		See figure 1; V_{CC} = 30 V dc; I_C = 4 A dc; I_{B1} = 16 mA dc	t_{on}		2.0	µs
Turn-off time		See figure 2; V_{CC} = 30 V dc; I_C = 4 A dc; I_{B1} = I_{B2} = 16 mA dc	t_{off}		8.0	µs
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; 100 kHz ≤ f ≤ 1 MHz	C_{obo}		200	pF

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 5						
Safe operating area (dc)	3051	T_C = 25°C +10°C; t = 1s; 1 cycle; See figure 3				
Test 1		V_{CE} = 8 V dc; I_C = 8 A dc				
Test 2		V_{CE} = 30 V dc; I_C = 2.13 A dc				
Test 3		I_C = 100 mA dc				
2N6298		V_{CE} = 60 V dc				
2N6299		V_{CE} = 80 V dc				
Safe Operating area (switching)	3053	Load condition B, (clamped inductive load); T_A = 25°C; $t_r + t_f \leq 1.0$ µs duty cycle ≤ 10% t_p = 1 ms; (vary to obtain I_C); R_s = 0.1 ohms; R_{BB1} = 80 ohms; V_{BB1} = 16 V dc; R_{BB2} = 100 ohms; V_{BB2} = 1.5 V dc; V_{CC} = 50 V dc; I_C = 8 A dc; $R_L \leq 2$ ohms; L = 1 mH; clamp voltage =				
2N6298		60 V dc				
2N6299		80 V dc				
Safe operating area (switching)	3053	Load condition C; (unclamped inductive load) See figure 4 T_A = 25°C; duty cycle ≤ 10%; $R_S \leq 0.1$ ohm				
Test 1		t_p = 1 ms (vary to obtain IC); R_{BB1} = 80 ohms; $V_{BB1} \geq 12$ V dc; R_{BB2} = ∞; $V_{CC} \geq 30$ V dc; I_C = 8 A dc; $R_L \leq 0.5$ ohms; L = 1 mH at 8 A dc				

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 5 - Continued						
Test 2		t_p = 1 ms (vary to obtain IC); R_{BB1} = 80 ohms; V_{BB1} ≥ 12 V dc; R_{BB2} = ∞; V_{BB2} = 0 V dc; V_{CC} ≥ 30 V dc; I_C = 0.2 A dc; R_L ≤ 0.5 ohms; L = 100 mH at 0.2 A dc				
End point electrical measurements						
Collector to emitter cutoff current	3041	Bias condition A; V_{BE} = 1.5 V dc	I_{CEX1}			
2N6298		V_{CE} = 60 V dc			0.5	mA dc
2N6299		V_{CE} = 80 V dc			0.5	mA dc
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 4 A dc; pulsed (see 4.5.1)	h_{FE2}	750	18000	
Subgroups 6 and 7						
Not applicable						

1/ For sampling plan, see MIL-S-19500.

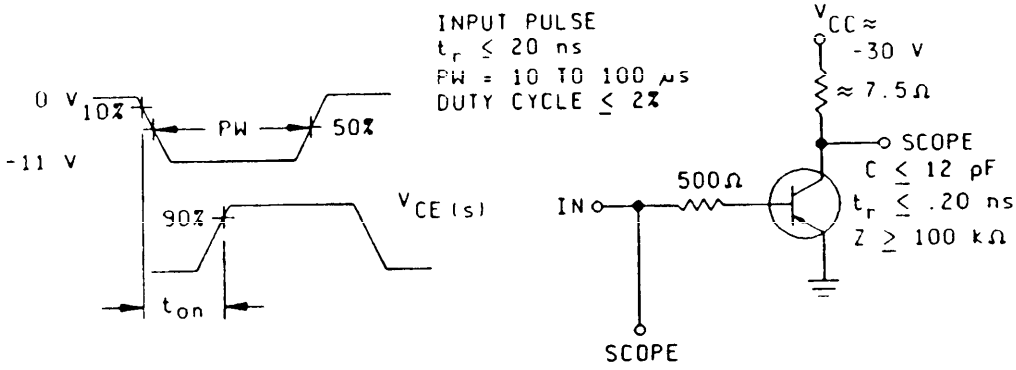


FIGURE 1. Turn-on time test circuit.

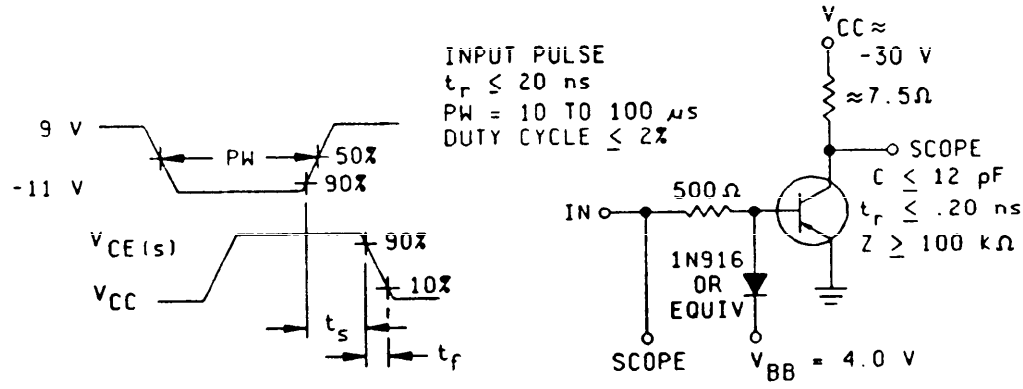


FIGURE 2. Turn-off time test circuit.

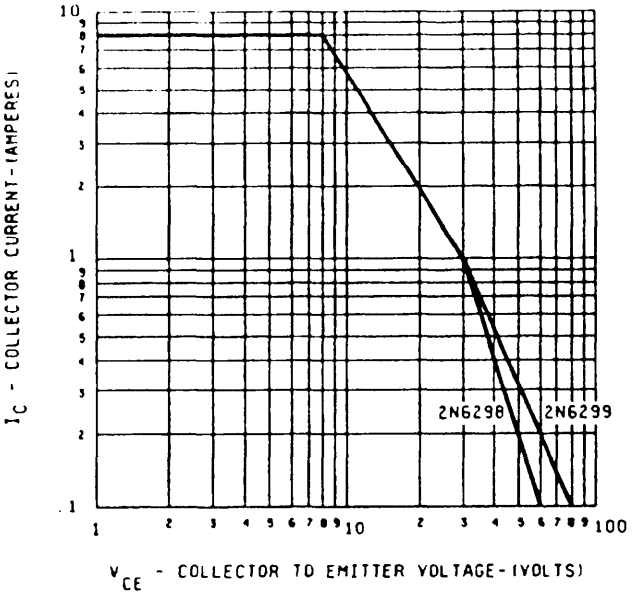


FIGURE 3. Maximum safe operating graph (dc).

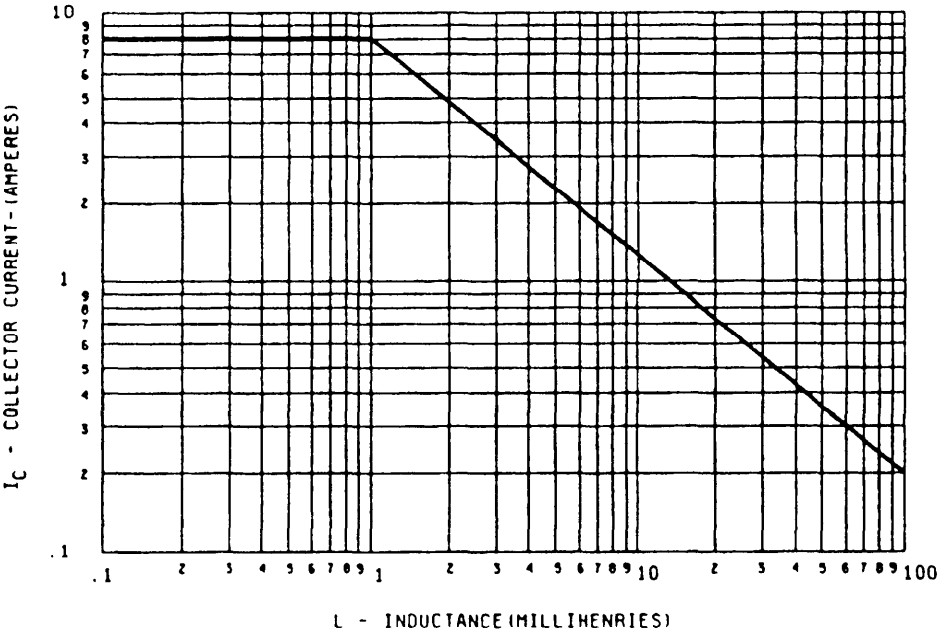


FIGURE 4. Safe operating area for switching between saturation and cutoff (unclamped inductive load).

6. NOTES

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Issue of DODISS to be cited in the solicitation.

b. Lead finish (see 3. 3.1).

c. Type designation and product assurance level.

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodian:
Air Force - 17

Review activities:
Air Force - 19, 85, 99

Preparing activity:
DLA - ES

(Project 5961-F118)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-S-19500/540A	2. DOCUMENT DATE (YYMMDD) 94/08/19

3. DOCUMENT TITLE

SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP SILICON, POWER TYPES 2N6298 AND 2N6299, JAN, JANTX, AND JANTXV

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME Alan Barone	b. TELEPHONE (Include Area Code) (1) Commercial 513-296-6048	(2) AUTOVON 986-6048
c. ADDRESS (Include Zip Code) Defense Electronics Supply Center Attn: DESC-ELDT Dayton, Ohio 45444-5765	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	